

A METHOD AND AN APPARATUS FOR PACKING ARTICLES HAVING NON-UNIFORM
WEIGHT

The present invention relates to a method and an apparatus for packing articles
5 having non-uniform weight.

Grader type weighing machines are building up a number of packages - at a
corresponding number of positions - in parallel. The articles are weighed one by one
(each article may consist of one item or a small groups of items) and after each
10 weighing it is decided to which position every single article is to be guided. The
decision is based on historical data from previously weighed articles and statistical
rules. When articles belonging to one package are assembled at the position they are
removed from there and the machine will begin the build-up of a new package at that
position. The positions will finish packages at a random pattern.

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The selection of articles for packages is often referred to as batching. An apparatus
and a method for such are known from WO 96/08322 and GB-A- 2 116 732.

According to this method in most cases, the process of selecting the articles (single
20 items or small groups of items) to the package are, as mentioned, based on historical
data from previously weighed articles and statistical rules.

The packages will have to meet certain parameters, such as

- a. target package weight (nominal package weight)
- 25 b. acceptable package overweight
- c. acceptable package underweight (this may often be zero)
- d. maximum item weight (optional)
- e. minimum item weight (optional)
- f. maximum number of items in the package (optional)
- 30 g. minimum number of items in the package (optional)

These parameters are defined prior to beginning the packaging process. Such a set of parameters can be referred to as a job. A grader can optionally run several jobs in parallel at the same time.

5 GB-A-2 116 732 discloses what is commonly known as the "funnel method" of batching and operates on the basis of an assumption that the articles which are to be packed have a normal (Gaussian) weight distribution. The weight distribution pattern for a normal Gaussian distribution, that is to say a graph showing the numbers of articles of different weights, is a bell-shaped curve having relatively few low and
10 high weight articles and having the majority of articles in a median region. Batching of articles by the funnel method is by placing low weight and high weight articles first into the batches, and then complete the batching by selection of articles whose weights progressively approach the median value of the Gaussian weight distribution curve.

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In the practice of the funnel method of GB-A-2 116 732, incoming articles to be batched may be sampled in order to define the parameters of the Gaussian weight distribution pattern that is utilized by the computer, and no other preliminary measurements or computations are made. The computer controls the batching
20 operation in dependence upon the Gaussian weight distribution curve and the basic assumption is made that articles of each and every weight value in the Gaussian weight distribution curve are available to be batched. This basic assumption leads to the problem that if a particular article weight or range of article weights is in fact not available, for example because articles of that weight or weight range have
25 previously been picked out to be sold separately at a premium price, then the batching process may stall because of the unavailability of suitable articles.

WO 96/08322 discloses a batching method and system which has been referred to as a "Camel Back" method on account of its ability to batch successfully a range of
30 articles having a weight distribution which is distinctly non-Gaussian on account of having two maxima or humps, like a camel.

In accordance with the method of WO 96/08322 the process of selecting the articles (single items or small groups of items) to the package are based on historical data from previously weighed articles and statistical rules. The historical data can be based on a simple first-in-first-out memory holding some of the previous weighed articles processed in a useful way to produce the decision background for selecting the position for the item in question.

Initially there are no historical data for a job, and a special software routine is needed to begin packing such a new job (explained in the following paragraph), but afterwards the historical data from last time the job was running can be kept in a memory to be called when the job is restarted.

A brand new job with no historical data in the memory can be initiated by guiding one article to each position allocated to that job. Normally this will produce sufficient "historical data" to run the job in an acceptable way until more data are produced.

The historical data are updated on a regular basis when the job is running.

In general terms, when an article has to be allocated into a position, it is simulated what happens if it is allocated to position 1, if it is allocated to position 2, etc. until all positions are simulated. Then the actual allocation is chosen as the best one of the simulation. In accordance with the method of WO 96/08322:

- The historical data is arranged as a histogram (by a background task for the controller).
- These histogram data are convoluted into other histograms showing combinations of 2 articles, 3 articles etc (also by a background task).
- The quantity missing in each position to meet the target parameters is calculated (each time an article is allocated).

- The new weighed article (the one to be allocated) is simulated put into each position and a new missing quantity is calculated for each position.
- This missing quantity is compared to the histogram and the convoluted histograms to investigate how the chances are to meet the target parameters. This is done for each position and a score is calculated - high score for good chances to meet the target parameters and low score for bad chances to meet the target parameters.
- When all scores are calculated the allocation is determined as the position with the highest score.

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As explained, when a job is running, the machine decides for each weighed article (single item or small group of items) where to put it. It happens that the machine decides that an article does not fit into any of the positions, if for instance the machine foresees that it will not be possible to finalise any of the packages at the positions within the parameters if the particular article is guided into any one of them. Such articles are generally re-circulated back to the input to give them a "second" chance. In general, re-circulation should be kept to a minimum because it is complicated, it reduces the capacity of the machine and the handling of the articles should be kept to a minimum due to any possible damages to it etc. Of obvious reasons the possibility to find a suitable position to any given article is bigger if more positions are allocated to the job in question.

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Despite the acceptable overweight range, the aim is to produce packages with as little overweight as possible and to use as many articles as possible without re-circulation. Of obvious reason this gives the best economy.

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In most cases only one type of articles (e.g. chicken wings) is packed together, but in some cases different article types are packed together (e.g. chicken wings, breasts, thighs and drumsticks) or different article types are packed independently on the same machine (e.g. chicken wings in some of the positions and chicken breasts in

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some other positions, or even right side chicken wings and left side chicken wings independently).

5 Same article type in different package size is often packed in parallel, e.g. packages of 500 g chicken wings are made in some of the positions (job 1) and packages of 2500 g chicken wings are made in some other positions (job 2) at the same time. It is often seen that this gives a better overall economy than packing the 2 jobs after each other.

10 In some rare cases a turn-device can be incorporated to turn some of the articles (e.g. fish) so they fit better into the packing material, or they can be led through different channels from different positions to land in the same packaging material in opposite direction (e.g. 6 fish in one box, 3 of which with tail in the same direction as the head of the remaining 3 ones).

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The weighing machine is generally of the automatic type and can be arranged in many ways, e.g. one or more hopper scale(s) or a weighing device arranged with a conveyor belt. When the articles are leaving the weighing machine they can be transferred onto a conveyor belt or, in some cases it can be one belt including
20 weighing means. The positions can be arranged as bins alongside the conveyor belt and the articles are removed from this conveyor belt by means of deflector wings or other mechanical devices (see a later paragraph) arranged alongside the conveyor belt.

25 If the machine is working with reflector wings, there is normally one wing per position bin. In some cases two positions are arranged in one bin outside each other. In that case the bin is equipped with a moveable split-plate. The placing of this split-plate will determine which position an article will be transferred to.

30 The deflector wings may be arranged on the opposite side of the conveyor as the position bins or they may be arranged on the same side as the position bins. If the

deflector wings are arranged on the opposite side than the position bins they are hinged in the end closest to the feeding end of the conveyor. They are to be turned when an article to be moved into a position bin is passing by. In this case there may be position bins only on one side of the conveyor. If the deflector wings are arranged
5 on the same side as the position bins they are hinged in the end opposite the feeding end of the conveyor. They are to be turned when an article to be moved into a position bin is passing by. In this case there may be deflector wings on both sides of the conveyor.

10 As it can be understood, various combinations of the above mentioned configurations can be arranged.

At all the above mentioned configurations, it is realised that the machine sometimes allocate an article into a position as the best choice and that it proves a little later that
15 this was a bad choice. In such cases it is seen that the position in question can stay unused (locked) for a while. This will influence the efficiency of the machine in a negative way. Of course to avoid this the criteria for allocating articles to positions can be changed to allow more overweight and/or more articles can be re-circulated. But, as already explained, overweight is ruining the economy and re-circulation is a
20 critical thing. Therefore there is always a balance to be found for risky allocation.

As it can be understood from the previous description there is often a time delay from the decision whereto to guide an article is taken until the article in question is actually taken from the conveyor belt and guided into the collection position.

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It is an object of the invention to provide an improved method and an apparatus for packing articles having non-uniform weight.

By the present invention, it is realised that the certainty of allocation can be
30 improved by delaying the decision and expanding the number of articles to be decided on from one at a time to a multiple of articles at the time.

According to the invention, this object is achieved by a method for batching articles having different weights into a plurality of batches at a number of collection
5 positions, wherein each completed batch comprises a plurality of articles and has a sum weight within a predetermined weight range, said method including:

- providing a serial flow of articles on a conveyor;
- weighing each article in the flow and recording the weights of the articles;
- conveying the recorded articles to a batching section;
- 10 • allocating the recorded articles to a collection position within a predetermined decision time period;
- placing an allocated article in the predetermined collection position; and
- emptying a collection position when the predetermined sum weight is obtained;
- whereby said allocation is performed on the basis of the weight of the recorded
15 articles that are not yet positioned in one of the collection positions, and the content of the predetermined collection position.

According to the invention, all articles, i.e. a multiple of articles that are not yet placed in a collection bin are available for allocation to a specific collection position
20 bin. Utilising the available computing power this method can improve the capacity as well as the quality of the building of packages, since several articles are available for allocation to a specific package, which is being built at each of the collection positions in the batching section.

25 This is maybe best understood by an illustration: Consider articles A and B on a running conveyor belt A being in front. Let us further assume the positions 1, 2, 3 and 4 alongside the conveyor 1 being the one closest to the inlet. Let us also assume that just after the weighing process of article A it appeared to be the best choice to allocate article A into position 4, and just after the weighing process of article B it
30 appeared to be the best choice to allocate article B into position 2. But - if it is possible to delay the decision and calculate the best choice for A and B

simultaneously it appears to be better to allocate both articles A and B together into position 3. The invention is about realising that it is possible to delay the decision.

5 In a preferred embodiment of the invention, there is included the step of establishing a historical frequency distribution on the basis of the recordings of the articles and using this historical frequency distribution in the allocation of recorded articles.

In this way, the allocation is improved and therefore the giveaway is reduced, fewer articles are re-circulated and the number of locked position situations reduced.

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Moreover, it is realised that the delayed decision technique improves the quality of the decisions also if the technique is implemented in the known designs. For instance, where some of the articles are already removed from the conveyor it is still an advantage to re-decide if something else is better than that already planned. It is
15 advantageous that a high number of articles are not placed in the collection positions. This means that the system according to the invention takes up more space than normally if the improvements are utilised to the full extend.

In the following, the invention is present by an illustration:

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- We consider a situation where articles A, B, C, D and E are running down a conveyor belt A being in front, and collection positions 1 to 6 alongside the conveyor position 1 closest to the inlet.
 - Let us assume that not used articles and articles for re-circulation are running over the end of the conveyor and let us call this position 7.

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 - Let us further assume that article A has passed the positions 1 to 3 leaving only positions 4 to 7 as possible for article A. Result 4 possibilities.
 - Similar we assume that article B has passed position 1 and 2 leaving only positions 3 to 7 as possible for article B. Result 5 possibilities.
 - And articles C, D and E have not passed any position leaving all positions 1 to 7
30 as possible for article C, D and E. Result 3 articles by 7 possibilities.
 - This results in $4 * 5 * 7 * 7 * 7$ possibilities equal to 6860 possibilities

The re-decision can advantageously be performed every time "an event" has occurred independently of the basic design, and with all the shown configurations described above and known from elsewhere. By "an event" is meant a new article weighed, a position emptied, and everything else creating a new condition for the result of a re-decision.

As an extra advantage it has to be realised that the complete content for a package can be found as one of the possibilities mentioned from pure combination. The chance for this is higher the fewer articles needed to make the package and the more articles available for the decision. Consequently, if the conveyor is long enough and holds a sufficient number of articles the machine will collect articles for many packages by pure combination. It is realised that the giveaway by this is attractively low.

Accordingly, the advantage when using the delayed decision technique is lower when using split-plates in the bins to make two positions in each and when using position bins on both sides compared to using single row position bins assuming a constant number of positions.

An alternative way of utilising this invention is to reduce the number of positions compared to the conventional way. This will give a comparable result but with a fewer number of positions, and so save space and cost.

Preferably, predetermined sets of batching parameters are defined for each batch and on which the allocation of articles is based, said predetermined sets of parameters include the following parameters:

- batch target sum weight
- acceptable batch overweight
- acceptable batch underweight

In addition, these predetermined sets of parameters further include some or all of the following parameters:

- maximum article weight
- minimum article weight
- 5 - maximum number of articles
- minimum number of articles.

By the invention it is realised that each article may consist of one or more articles, said articles preferably being food articles.

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In an embodiment of the invention, some or each of the collection positions are provided with a bin, which preferably is subdivided into two collection bins, and that an article may be directed to one of the two collection bins in response to the allocation of the recorded articles.

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The articles are preferably provided in a continuous flow through the weighing and the batching section. The flow rate may be relatively high as the available computing power increases and the control system of the apparatus hereby can perform the calculations for the allocation relatively quickly. By the invention, it is however realised that an intermittently flow of articles may be provided.

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According to the invention, there is also provided an apparatus for batching articles having different weights into a plurality of batches at a number of collection positions, wherein each completed batch comprises a plurality of articles and has a sum weight within a predetermined weight range; said apparatus comprising:

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- weighing means for recording the weight of the articles;
- means for conveying articles provided thereon in series, said articles being conveyed through the weighing means and into a batching section;
- computing means for allocating the recorded articles to a collection position

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within a predetermined decision time period; said allocation is performed on the

basis of the weight of the recorded articles that are not yet placed in one of the collection positions, and the content of the predetermined collection position;

- deflection means for directing each of the articles into the predetermined collection position in response to a computed allocation; and
- 5 • means for emptying a collection position when the predetermined sum weight is obtained.

Hereby, an apparatus is provided for performing the method according to the invention.

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In the following, the invention is described in more detail with reference to the accompanying drawings, in which:

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Fig. 1 is a schematic top view of a batching apparatus for batching out articles according to a first embodiment;

Fig. 2 is a detailed view of a part of the batching section of the apparatus of fig. 1;

Fig. 2a is a cross-sectional view of the section A-A of fig. 2;

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Figs. 3-6 are partial schematic views of other embodiments of a batching apparatus;

Fig. 7 shows a schematic top view of a batching apparatus utilising a method according to the invention;

Fig. 8 shows another embodiment of a batching apparatus utilising the method;

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Figs. 9 to 13 are flow diagrams illustrating the data flow for the batching method according to the invention on an apparatus as shown in fig. 7.

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Figure 1 shows a schematic view of a batching apparatus having weighing means 1 and a batching section 2. The weighing means 1 is generally of the automatic type and can be arranged in many ways, e.g. with one or more hopper scale(s) or a weighing device arranged with a conveyor belt. When the articles or small groups of articles are leaving the weighing means 1, they can be transferred onto a conveyor

belt 3. The arrow T in fig. 1 indicates the article transport direction. In some embodiments, it can be one belt including weighing. A number of packing bins 4 are arranged alongside this conveyor 3 and the articles are removed from this conveyor 3 by means of deflector wings 5 or other deflection means arranged alongside the conveyor 3. Each deflector wing 5 is arranged in association with a bin 4. The deflector wings 5 are pivotably arranged on a hinge 6. Thus, the deflector wings 5 may be hinged "upstream", as shown in e.g. fig. 1 or "downstream" hinged as shown in fig. 3.

10 Of other deflection means the following can be mentioned: pushers of various kinds, air blast, or the conveyor itself can be divided into a number of small conveyors each able to tilt either longitudinal or transversal to remove the article (or the small of articles) from the main stream. It can also be a number of bins underneath each other each with bottom flip plates to direct the article(s) into the chosen next bin 4.

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The apparatus is preferably provided with deflector wings 5, where there is normally one wing 5 per position bin 4. In some cases, two positions are arranged in one bin 40 outside each other, as shown in fig. 2 and fig. 2a. In that case, the bin 40 is equipped with a moveable split-plate 41. The placing of this split-plate 41 will determine which position an article will be transferred to, i.e. if the article is transferred to the first compartment 42 or the second compartment 43 of the split bin 40 (see fig. 2a).

25 In one embodiment, the deflector wings 5 may be arranged on the opposite side of the conveyor as the position bins, as shown in fig 1 or in another embodiment they may be arranged on the same side as the position bins, as shown in fig. 3.

If the deflector wings 5 are arranged on the opposite side than the position bins 4, they are hinged in the end closest to the feeding end of the conveyor 3 (i.e. upstream). They are to be turned when an article 10 (or a little group of articles) to be

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moved into a position bin 4 is passing by. In this case, there may be position bins 4 only on one side of the conveyor (see fig. 1).

5 If the deflector wings 5 are arranged on the same side as the position bins 4, they are hinged in the end opposite the feeding end of the conveyor (i.e. downstream). They are to be turned when an article 10 (or a little group of articles) to be moved into a position bin 4 is passing by. In this case, there may be deflector wings 5 on both sides of the conveyor 3 as shown in fig. 4.

10 In another embodiment, two rows of articles 10 are arranged alongside each other and the weighing process is arranged so that the articles 10 running in the first row 1' are weighed independently of the articles 10 running on the second row 1". In this embodiment, a conveyor 3 with deflector wings 5 hinged in the end opposite the feeding end is preferred because such deflector wings 5 can be arranged on both
15 sides to move articles 10 only from the row closest, as shown in fig. 5.

Two or more conveyors 3', 3" can be arranged close to each other allowing them to share position bins 4 arranged in the space between them. In such cases articles weighed in a weighing apparatus 1' arranged in association with the first conveyor 3
20 and articles weighed in a weighing apparatus 1" arranged in association with the second conveyor 3" can be packed together in the same package, as shown in fig. 6.

As it can be understood from the figures, various combinations can be arranged. For instance, the bins 40 with split-plate 41 (see fig. 2) can be used in combination with
25 the apparatuses shown in any of figures 3, 4 and 5, and the downstream deflector wing (see fig. 3) can be used in combination with "centre" position bins 4 (see fig. 6).

Quite often, the process of moving the articles from the positions to the packing
30 material has to be done manually to present the articles in the best possible way in the package. This applies for instance when packing chicken parts. Consequently a

worktable has to be provided and also quite often a presentation tray for the articles be packed, underneath the position bin and a conveyor belt to remove the finished packages from the operator workspace (not shown).

- 5 All types of position bins can be equipped with one or more bottom gate(s) to increase the active operation time of that particular position. The advantage is easily acknowledged when we consider a situation where several positions in front of an observed operator have finished their packages almost simultaneously. The operator needs time to move the articles from the presentation tray to the packaging material.
- 10 Therefore the position(s) waiting to be attended to will be idle if not accommodated suitable. The bottom gate will provide a buffer feature and so the content for a second package can be assembled on top of the gate while the content for the first package is waiting in the presentation tray.
- 15 If needed, several gates can be arranged on top of each other to expand the buffer capacity.

- If the articles are not moved from the position bins to the packing material at the place of the position bins, a so-called takeaway conveyor can be installed underneath
- 20 the position bins. This conveyor transfers the articles to a remote place where they are moved from the conveyor belt to the packing material either automatically or manually. In such cases, the position bins have to be equipped with at least one level of buffer (as described above) to enable the positions bins to hold the articles until all the articles to form a package are collected. When all the articles are collected, the
 - 25 articles are released from the position bin at an empty spot on the takeaway conveyor belt. A controller will keep track of the articles on the conveyor belt so the articles belonging to another package will not be released at the same spot on the belt - this to avoid mixing articles belonging to various packages.
 - 30 The articles may alternatively be collected directly from the deflector wings in wheeled containers placed alongside the conveyor.

With reference to the batching apparatus shown in figure 7, the batching out of the articles 10A...F may advantageously be performed as explained in the flow charts of figures 9 to 13. As shown in figure 7 and in figure 8, the articles 10A...F are weighed
5 on a the scale 1 and flow in the direction T into the batching section 2 on a conveyor 3 where a number of position bins 4 are arranged. Deflector wings 5 are arranged on the conveyor 3 in association with each of the bins 4. In figure 7, the batching section is arranged with a bin-free "run-in" section 21 on the conveyor 3, whereas the embodiment of figure 8 is of a more traditional and compact nature. The bins 4
10 assigned consecutive numbers, counting up from the bin closest to the inlet of the articles (for explanatory purposes indicated by I, II, III, IV, V, VI in figures 7 and 8). Position VII is used as the designation for the articles decided for re-circulation, here they are going over the end of the conveyor.

15 The advantage of the batching method according to the invention will be appreciated from the explanatory examples shown in figures 7 or 8 together with the flow charts of figures 9 to 13. In principle, all weighed articles, i.e. 10A to 10E in figure 7 are available for selection for a specific bin as long as the article has not yet passed the specific bin. With reference to fig. 7, according to the invention, for instance, the
20 articles 10A to 10E are available for bins No. V and No. VI, whereas only articles 10C, D and E are available for bin No. I to VI. As soon as article 10F is recorded, this article is also available for selection for these bins.

The method of selecting the most suitable article for a specific bin is preferably
25 carried out as outlined in the flow charts 1 to 5, shown in figures 9 to 13. As described in "Flow 1" in fig. 9, the control system focuses on the highest position of the bin and then goes on to check if article 10A (or simply identified by "A"). If not, the focus is shifted to the next lower position. If article 10A is available, it is checked if the bin in focus will be overfilled, i.e. go outside the tolerances for the batch,
30 which is being built on this bin. This is checked by increasing the content record with the recorded weight of article 10A, i.e. pre-allocating the article to the bin. If the

focused bin is overfilled, the content record is reduced again, i.e. the pre-allocation is cancelled. However, if article 10A is suitable, the system goes on to check article 10B, as shown in "Flow 2" in fig. 10. If article "B" is suitable, the system goes on to check article 10C (or "C"), as shown in Flow 3 of fig. 11. If article "C" is suitable,
5 the system goes on to check article 10D (or "D"), as shown in Flow 4 of fig. 12, etc. When the last of the recorded articles 10E (see fig. 7) have been checked, the calculations for all positions are done and a combined score is calculated.

As it is understood from the flow charts, a set of calculations are performed for each
10 combination of article allocation and every time the combined score is compared with the previous combined score and the best outcome is kept.

When all combinations have been calculated a particular combination of allocations is found as the best one. However this will only be carried out for the articles moving
15 into kick-off vicinity of the corresponding deflector. The allocation of an article to a bin is thus frequently changed every time a new article enters the conveyor 3, i.e. has been recorded on the scale 1.

By having a long "run-in" section 21, as it is the case in fig. 7, a large amount of
20 articles may be available at the time for allocation. However, as shown in fig. 8, a less elongated batching apparatus may be designed.

The flow charts shown are adapted to the situation with five articles to be allocated. It is of course realised that the control system is automatically adapted to any
25 situation, i.e. any number of articles. The associated software programming is adapted to perform this allocation process irrespective of the number of articles to be allocated at the time.

In a first embodiment the method according to the invention, the articles is carried
30 out with the articles in focus, where every possible allocation of the first article 10A is combined with every possible allocation for the second article 10B, which again is

combined with every possible allocation for the third article 10C on the conveyor 3 and so forth. According to a second embodiment of the method of the invention, the collection positions, i.e. the position bins are chosen as the basis, where every possible allocation of articles to a bin VI is combined with every possible allocation of remaining articles for bin V, which then is combined with every possible allocation of remaining articles for bin IV, etc. Both principles may be used in order to optimise the allocations of articles amongst the "search space", i.e. the number of possible combinations.

- 10 The number of possible allocations is limited by the elimination of combinations of articles where the sub-batches in the bin exceed the weight limits. Besides, it may be advantageous in some cases to further limit the search space, a limit to the amount of articles which are included in the search could be introduced, and/or it could be practical to operate with a run time controlled maximum value on the amount of combinations which are included in the final selection process.

The ultimate criterion for the search result, i.e. the optimal allocation, is characterized in that:

- 20 i) All items are allocated to one of the allocation possibilities associated with the items, or the items are rejected resulting in a given combined preference value.
- ii) There does not exist any alternative allocation combination which gives a better combined preference value.

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It is realised that various allocation parameters may be used for the process of allocating the articles to the positions without departing from the scope of the invention as set forth in the accompanying claims.